This dead of midnight is the noon of thought,
And Wisdom mounts her zenith with the stars.
—Mrs. Barbauld.

Honolulu Star-Bulletin

God grants liberty only to those who love it, and are always ready to guard and defend it.—Webster.

HONOLULU, TERRITORY OF HAWAII, SATURDAY, OCTOBER 14, 1916.

NEWS AND PRACTICAL INFORMATION ABOUT AUTOMOBILES

RELATIONS OF CURRENT, PRESSURE AND RESISTANCE IN ELECTRICAL SYSTEM EXPLAINED

Herewith is presented the third instalment of a weekly series of articles designed to give the motorist the knowledge necessary to enable him to care for and repair any and all of the electrical features of his car, no matter what make or model it may be.

With the ground work well laid by study of the early portion of the series, the reader will be able to think electrically, and a tangle of wire under a car or a tangle of lines on a wiring diagram will become clear.

The articles are reproduced by permission from Motor Age, for which they are prepared by David Penn Moreton and Darwin S. Hatch.

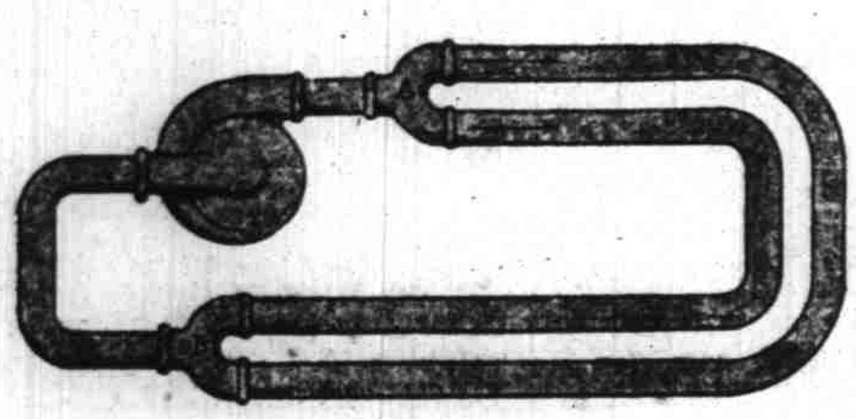


Fig. 1—A parallel water circuit

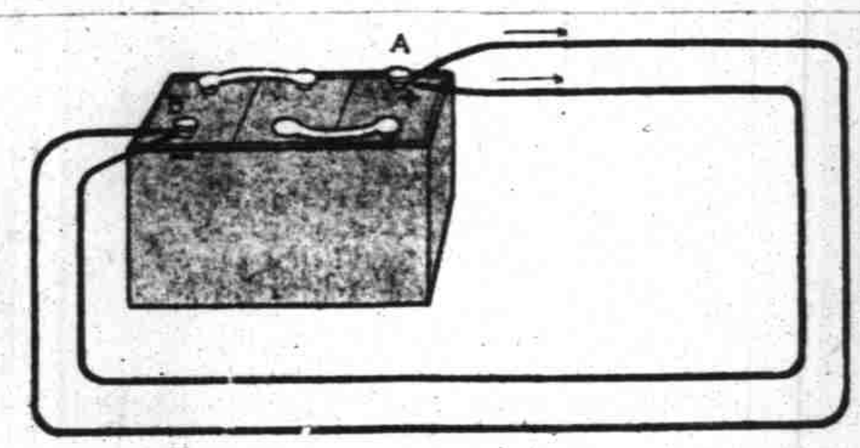


Fig. 2 —A parallel electric circuit

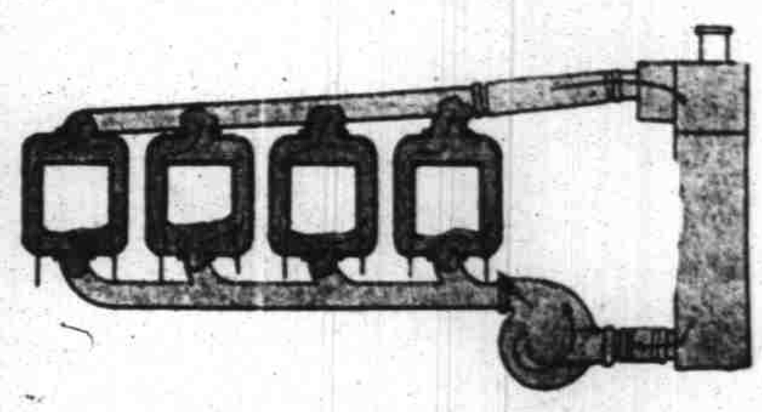


Fig. 3 —Parallel water circuit in car's cooling system

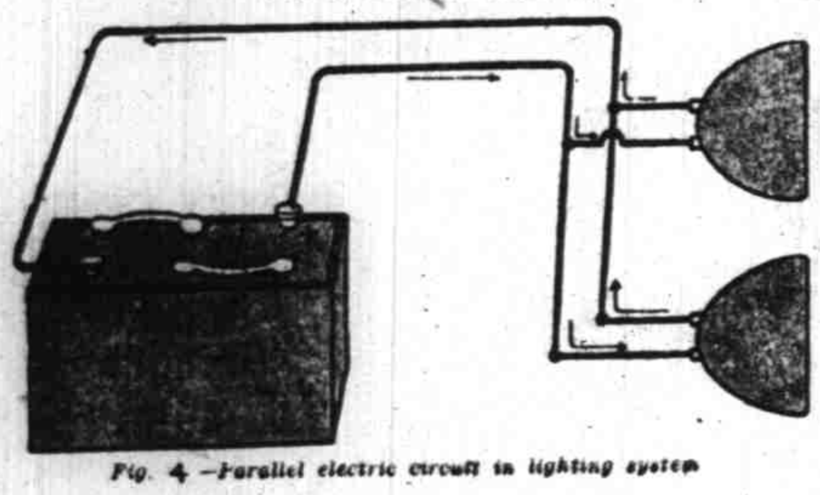
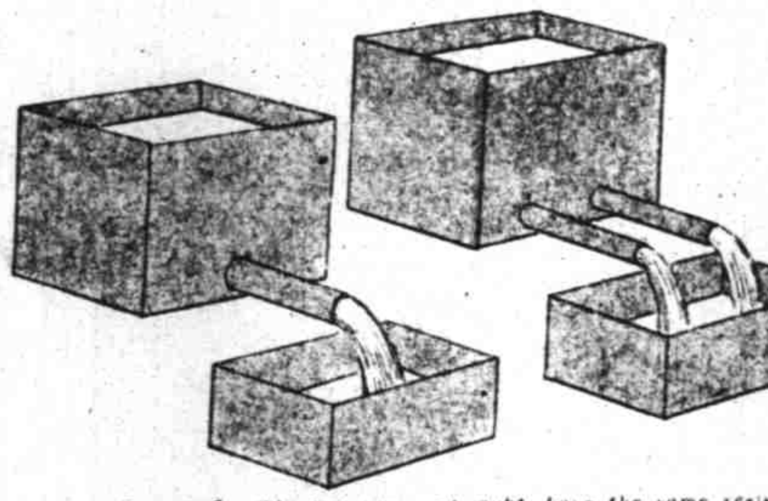


Fig. 4 —Parallel electric circuit in lighting system



Figs 5 and 6 – The two pipes, at right, have the same resistance as one pipe, at left, if the combined areas of the two small pipes are equal to the area of the large pipe

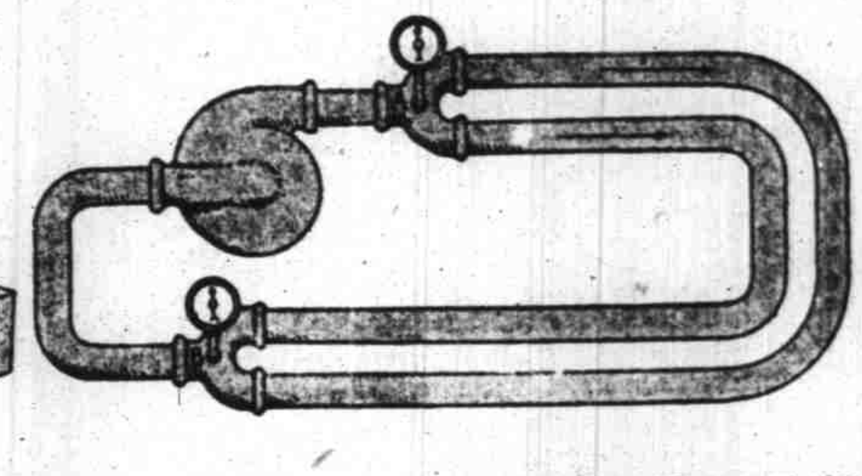


Fig. 7 —The difference of the readings of the two pressure gauges at either end of the parallel water circuit represents the pressure on each pipe

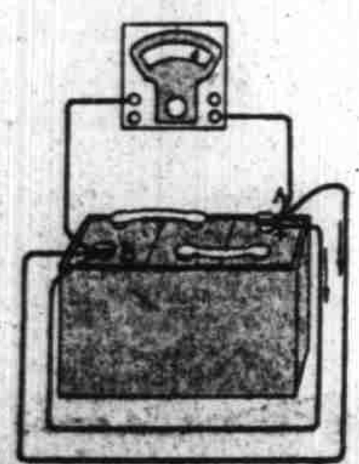


Fig. 8 —The voltmeter across the ends of the branches in a parallel electric circuit shows the pressure in each branch, since the pressure is the same in each branch

COURTESY of MOTOR AGE

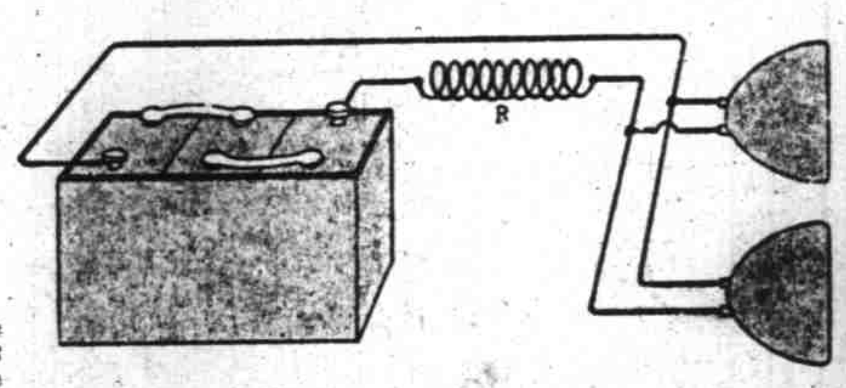


Fig. 9 —A combined series and parallel lighting circuit, in which the lamps are in parallel and a resistance coil in series with the battery

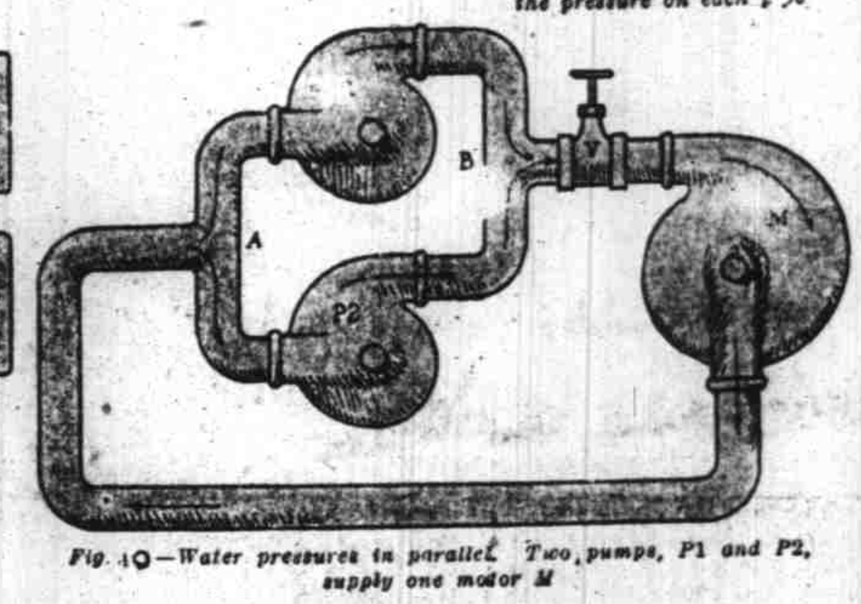


Fig. 10—Water pressures in parallel. Two pumps, P1 and P2, supply one motor M

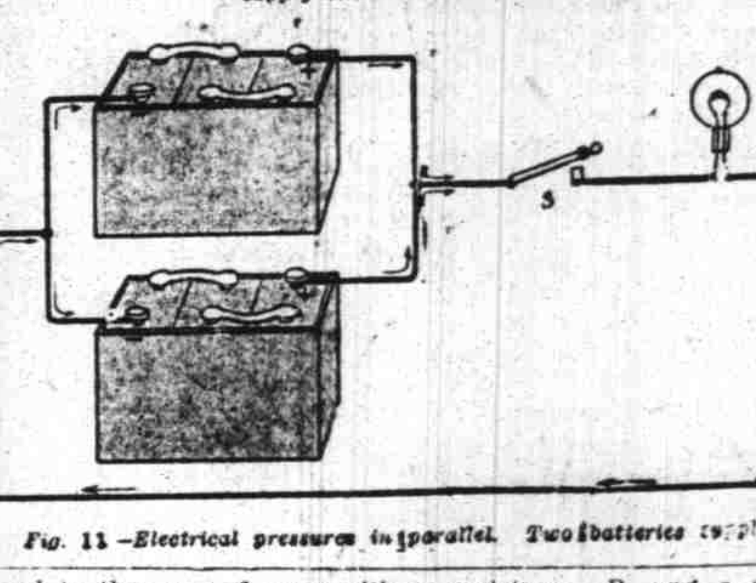


Fig. 11 —Electrical pressures in parallel. Two batteries supply

If a water circuit is composed of two pipes and they are connected in the manner indicated at A and B in Figure 1, they are said to be connected in parallel or multiple. There are two paths in which the water may flow in passing along the circuit from the point A to the point B, and just as much water is returning to the pump in a given time as is leaving it. The quantities of water passing through the different pipes in a given time or the currents of water in the different pipes connected in parallel are not necessarily equal unless the resistances of the different pipes are the same. The water is not used up in the operation of such a circuit.

An electrical circuit composed of two or more different wires of perhaps different sizes, lengths and material, and connected as shown in Figure 2, is called a multiple or parallel circuit. In this case there are as many paths for the electricity to flow through in passing from the positive terminal to the negative terminal, through the circuits outside the battery, as there are different wires in parallel. Just as much electricity is returning to the battery in a given time as is leaving the battery. The quantities of electricity passing through the different paths in one second or the currents in the different paths of the parallel circuits are not necessarily equal unless the resistances of the different paths are the same. Just remember that the electricity is not used up in the operation of such a circuit.

A parallel water circuit is found in the operation of the cooling system of a motor car engine, as shown in Figure 3. In this case the water jackets of the four cylinders are all connected in parallel, and the pump forces the water through the water jackets and radiator. The current of water through the pump and radiator is the same and equal to the combined currents through the four water jackets. The currents in the different water jackets are not necessarily equal unless the opposition offered to the flow of water through the different jackets is the same in each case. It is obvious that if the water jacket of one cylinder offers a greater opposition to the flow of the water than the other water jackets there will be a smaller current through this jacket than through the others. The water jacket offering the greatest opposition to the flow of water will have the smallest current, while the water jacket offering the smallest opposition always will have the largest current. The current in the remaining paths will have a value somewhere between the above maximum and minimum values.

When the headlights on a motor car are connected, as shown in Figure 4, they form a typical parallel electrical circuit. Just as much electricity returns to the battery in a given time as leaves the battery. The current in each of the lamps is not necessarily the same. Remember, the electricity is not consumed in the lamps.

Resistance of Parallel Circuits

Since the resistance offered by a pipe to the free flow of water through it decreases with an increase in the size of the pipe, the length remaining constant, it is evident that the resistance offered by two pipes connected in parallel will be less than the resistance of a single pipe. If the two pipes are of exactly the same size and length they will, when connected in parallel, offer one half of the resistance to the flow of water through the circuit that is offered by a single pipe.

For convenience the two pipes, as shown in Figure 5, might be considered as being equivalent to a single pipe, as shown in Figure 6, whose length is the same as that of each of the two pipes and whose area is equal to the combined area of two pipes, which will be twice that of either pipe, since the pipes are equal in area. The resistance of this large pipe, which is to replace the two smaller ones, will be one-half of that of either of the single small pipes, since its area is equal to twice the area of either of the two small pipes.

Two wires of the same size and length and of the same material will, when connected in parallel, offer a resistance which is equal to the resistance of a wire of the same material and having the same length but having an area equal to twice the area of either wire. Thus the resistance of two wires of the same dimensions and material will offer, when connected in parallel, one-half of the resistance of either wire alone. Any number of electrical resistances connected in parallel might be thought of as being equivalent to a number of wires of the same length and material but having the same or different areas. Their combined resistance, then, will be equal to the resistance of a single wire of the same material and same length and whose area is equal to the sum of the areas of the several different wires.

Various Resistances

For example, if two resistances of 6 and 3 ohms, respectively, be connected in parallel their combined resistance may be determined as follows:

For convenience let us assume that these two resistances are two wires of the same material and that they are equal in length. Then the area of the 3-ohm wire will be twice the area of the 6-ohm wire, since its resistance is one-half as great, the area increasing as the resistance decreases. The two wires will have a combined area equal to three times the area of the 6-ohm wire. The resistance of a wire whose area is three times that of another wire of the same material and having the same length will be one-third of the resistance of the smaller wire.

Hence the resistance of a wire which may replace the two wires is equal to one-third the resistance of the 6-ohm wire, or 2 ohms.

Suppose three resistances of 4, 3 and 12 ohms, respectively, be connected in parallel. Their combined resistance may be determined as follows:

Again let us assume that these resistances are three wires of the same material and all have the same length; then the area of the 4-ohm wire will be three times as great as the area of the 12-ohm wire and the area of the 3-ohm wire will be four times as great as the area of the 12-ohm wire.

The three wires will have a combined area equal to 1 plus 3 plus 4, or eight times the area of the 12-ohm wire. This equivalent wire, whose area is eight times the area of the 12-ohm wire, will have a resistance equal to one-eighth of the 12-ohm wire, or 1 1-2 ohms.

Any number of resistances may be combined in the above manner by first assuming them as composed of the same material and having the same length and then replaced by a wire of the same material and same length, but having an area equal to the combined area of the several wires.

Conductance

The resistance of the electrical circuit is a property of the circuit which opposes the free flow of electricity through the circuit, and it is measured in a unit called the ohm. The property of the circuit which permits the electricity to flow, or that property which is just the opposite of resistance and is equal to 1 divided by the resistance in ohms, is called the conductance of the circuit, and it is measured in a unit called the ohm. It is interesting to note that the unit in which the conductance is measured is the unit of resistance, the ohm, spelled backward.

The resistance of a parallel circuit may be determined by merely adding the conductances of the several parts just as the resistance of a series circuit may be determined by adding the resistance of the different parts. For example, if two resistances of 6 and 3 ohms, respectively, are connected in parallel their resistance may be determined as follows: The conductance of the 6-ohm branch will be equal to 1 divided by 6, or 1-6 mho, and the conductance of the 3-ohm branch will be equal to 1 divided by 3, or 1-3 mho. The total conductance of the divided circuit will be equal to the sum of the conductances of the two branches, or total conductance equals 1-6 plus 1-3, equals 3-6 mho. Since the conductance of a circuit is equal to 1 divided by the resistance, then the above relation may be written as follows:

$$\frac{1}{\text{resistance}}=3\text{-}6$$

or the resistance=6-3=2 ohms

Suppose three resistances of 6, 3 and 12 ohms, respectively, be connected in parallel, then their combined resistance may be determined as follows:

total conductance=1-4 +1-12+1-3
=3-12+1-12+4-12
=8-12mho

$$\text{then}\ \frac{1}{\text{resistance}}=8\text{-}12$$

or, the resistance=12-8=1½ ohms.

If two headlights whose resistances are 4 and 2 ohms, respectively, be connected in parallel, what will be the value of their combined resistance? The conductance of the two branches of the divided circuit formed by the two lamps will be one-fourth and one-half mho, respectively, and the total conductance will be:

total conductance=¼+1-2
=¼+2-4
=¾ mho

$$\text{then}\ \frac{1}{\text{resistance}}=\frac{3}{4}$$

or, the resistance=4-3=1 1-3 ohms.

Therefore the two lamps will have a combined resistance of 1 1-3 ohms.

When any number of equal resistances are connected in parallel the total resistance is equal to the resistance of one of the resistances divided by the number of resistances connected in parallel. For example, if six 4-ohm lamps are connected in parallel the total resistance of the combination will be equal to 4 divided by 6, or 2-3 ohm. Remember, this method of determining the resistance of a parallel circuit holds true only when the value of the different resistances is the same.

If pressure gauges be connected to the water circuit at the points A and B, as indicated in Figure 7, the difference in the readings of the two gauges will represent the pressure acting on each of the pipes forming the parallel circuit. It is obvious, from an inspection of this figure, that the pressure acting on each of the branches of a parallel or divided circuit is at each instant exactly the same.

If a voltmeter be connected to the electrical circuit at the points A and B, as indicated in Figure 8, the pressure indicated by the voltmeter will represent the value of the pressure acting on the divided circuit, and it is obvious that the pressure acting on each of the several branches of a parallel circuit at any instant is exactly the same, since each branch is connected between the same two points. If several lamps are connected in parallel the pressure acting on each of the lamps will be the same, regardless of their candle power or voltage ratings.

Current Relations for Parallel Circuit

If two pipes of the same size and same length be connected in parallel and the combination in turn connected to a pump, the current of water in each of the pipes will be the same, since they each offer the same resistance and the same pressure is acting on each of them. If, however, one of the pipes be longer than the other, their size being the same, or if one pipe be smaller than the other, their lengths being the same, the current of water in the two pipes will not be the same. The current of water in the pipe which offers the greater resistance will be less than the current of water in the pipe which offers the less resistance. For example, if the resistance of one pipe is twice as great as the resistance of the other pipe, then the current in it will be one-half as great as the current in the other pipe.

If two equal electrical resistances be connected in parallel they will each carry the same current. For example, if two 12-volt headlights of the same make and same candle power be connected in parallel to a 12-volt battery the current in each of the lamps will be practically the same. The total current supplied by the battery will be equal to the sum of the currents in the two branches. If, however, two resistances which are unequal in value be connected in parallel the current in the resistances will not be the same.

The branch of the divided circuit having the larger resistance will carry the smaller current, while the branch of the divided circuit having the smaller resistance will carry the larger current. The total current supplied to the divided circuit will be equal to the sum of the currents in the two branches, regardless of whether these are equal or not. Thus, if two 6-volt lamps which take currents of 3 and 2 amperes, respectively, be connected in parallel to the terminals of a 6-volt battery the total current taken by the lamp will be equal to 3 plus 2, or 5 amperes.

From the above discussion it is obvious that lamps made to operate on different voltages cannot be operated satisfactorily in parallel, because if the voltage is adjusted to the proper value for one lamp it is not correct for the other. In the case of the series circuit the lamps had to take the same current in order to operate satisfactorily in series.

The relation of the currents in the two branches of a divided circuit is just the reverse of the relation between the resistances of the two branches of a divided circuit are 4 and 8 ohms, respectively, then the current in the 4-ohm branch will be twice as great as the current in the 8 ohms, since the resistance of the 4-ohm branch is one-half the resistance of the 8-ohm branch.

The total current supplied to a parallel circuit of any number of branches is equal to the sum of currents in all of the different branches, and the relation of the currents in the different branches is just the reverse of the relation of the resistance of the different branches.

Examples Illustrating Relations

If three resistances of 6, 3 and 2 ohms, respectively, are connected in parallel the relation of the currents in the different branches will be as follows: The current in the 2-ohm resistance will be equal to three times the current in the 6-ohm resistance and and one-half times the current in the 3-ohm resistance. The current in the 3-ohm resistance will be equal to twice the current in the 6-ohm resistance and two-thirds of the current in the 2-ohm resistance. The current in the 6-ohm coil will be equal to one-half of the current in the 3-ohm coil and one-third of the current in the 2-ohm coil.

The resistance of the winding of an electric heater which is made to operate on a 12-volt battery is 3 ohms. What will the resistance of this heater be if a second winding of 6 ohms is connected in parallel with the first winding, and what current will the heater take from a 12-volt battery after the second winding is put in place?

The combined conductance of the two windings is equal to

1-3+1-6=2-6+2-6=3-6 mho;

then the resistance will be equal to 6 divided by 3, or 2 ohms

The current taken by the 6-ohm winding will be equal to 12 divided by 6, or 2 amperes, and the current taken by the 3-ohm winding will be equal to 12 divided by 3, or 4 amperes. The total current taken by the heater after the second winding is put in place will be equal to the sum of the currents taken by the two windings; that is, 2 plus 4, or 6 amperes.

The total current can be obtained by dividing the pressure acting on the heater by the combined resistance of the two windings, as follows:

$$1=\frac{12}{2}=6\ \text{amperes}$$

Combined Series and Parallel Circuits

An electrical circuit may be a combination of one or more series and parallel circuits, as shown in Figure 9, which represents two headlights in parallel with each other, and this combination in turn connected in series with a resistance, R, and a storage battery. This is the principle used in some methods of dimming head lights. The sum of the currents through the two lamps is equal to the total current or the current in the resistance. The total resistance of this circuit is equal to the sum of the resistance of the parallel portion and the resistance of the remainder of the circuit. For example, if the resistance of the two lamps is 4 ohms each and the resistance of the coil in series is 3 ohms the total resistance can be determined as follows:

Since the two lamps have equal resistances, their combined resistance will be equal to 4 divided by 2, or 2 ohms, and the total resistance will be equal to 2 plus 3, or 5 ohms.

If the voltage of the battery is 6 volts the current in the circuit will be equal to 6 divided by 5, or 1.2 amperes. The value of the current in each of the lamps will be the same, since the two paths of the divided circuit have the same resistance, or one-half of the 1.2, or .6 ampere. The pressure over the two lamps in parallel will be the same part of the total pressure as the resistance of the two lamps in parallel is a part of the total resistance. The resistance of the two lamps in parallel is 2 ohms, and the total resistance is 5 ohms. Hence, the pressure over the lamps will be equal to 2-5 of 6, or 2.4 volts.

The pressure over the 3-ohm resistance will be equal to 3-5 of 6, or 3.6 volts. Or, if the drop over one part of the circuit is known the drop over the other part will be equal to the total pressure minus the drop over the first part. Thus, the drop over the two lamps in parallel is 2.4 volts. Then the drop over the 3-ohm resistance will be equal to 6 minus 2.4, or 3.6 volts.

Pressures in Parallel

If two pumps be connected, as shown in Figure 10, they are said to be connected in parallel, and the sum of the currents of water through the two pumps will be equal to the total current in the main pipes and water motor, M, provided the currents in the two pumps are both in the same direction; that is, say, from the point A to the point B, as indicated.

Let us assume that the valve V in the main current is closed so that

(Continued on page 25)

ENTIRE PURCHASE PRICE OF TIRES TO BE REFUNDED

Goodyear Tire Co. Gives Back Full Purchase Price on S.-V. Tires Which Fail

When the Goodyear Tire & Rubber Company announced its offer some time ago to refund the entire purchase price if Goodyear s-v tires failed to prove superior to competing makes on a basis of cost per mile, many truck tire users naturally wondered how it was possible to make such a sweeping and positive challenge.

Later it developed that the Goodyear company had used its offer on the records of 5000 test tires and knew positively just what the tires would do. The response to the challenge on the part of truck owners was magnificent and rendered it a complete success.

At the termination of the offer only a few tires—of the many hundreds sold had failed—as the best of tires occasionally will. So that Goodyear s-v's emerged triumphantly after a campaign unique in motor truck tire history.

"During the past few months," says C. W. Martin, Jr., Manager of the Goodyear motor truck tire department, "we have received many valuable testimonial letters from the owners of these tires, which prove even more than we claimed for them.

"We have been jotting down the mileage mentioned in these letters from satisfied customers, and have found that s-v's have made average mileages of what were formerly considered exceptional mileages—so that not only do these tires cost least per mile, but they show the greatest average mileage.

"A list of mileages from 700 of these s-v tires, selected at random, shows an average of 13,705 miles per tire to date—nearly double our written mileage guarantee of 7000 miles. Many of them are not half worn out. Naturally we feel that our position in the motor truck tire world is practically unassailable.

"S-V tires are pressed on the rim by hydraulic pressure. They are forced on the wheel base under an average pressure of 75 tons. This prevents any possibility of creeping and eliminates all auxiliary fastenings."

"DEATH VALLEY DODGE" TREKS INTO MEXICO IN GREAT TOURING TRIAL

With the return of "Death Valley Dodge" to Los Angeles a few days ago this car of many travels finished another run of unusual interest.

Now-a-days Mexico is shunned by every motorist, but despite that fact "Death Valley Dodge" was driven from Calexico through Mevicali and south to the recently exploited mud volcanoes that are creating such a disturbance far down in the Mexican Peninsula south of Imperial valley.

According to Fred Alkire, who drove the famous old car on this, its latest journey, it was a trip to test the stamina of both car and river.

"The only roads through that region," said Mr. Alkire, "are rough trails, first along the banks of the irrigation ditches, then across the mesquite covered mesas, and finally over the barren alkali slopes, leading right to the base of the mud volcano.

"No car had ever climbed to this point before, and few if any will ever make the attempt again. Oftentimes we were up to the hubs in sand, then across bottomless sloughs a mile or more in width, where we were over the running board in liquid mud. The last pull up the mud volcano slope the car was warped and twisted as it first lifted one wheel over a three-foot mud hummock, only to plunge into and through a hole equally as deep.

"The mud volcanos cover a wide area where there are miniature geysers, black oozing mud being ejected above the surrounding surface as though it were some gigantic caldron filled with boiling molasses.

"The surrounding air is full of steaming stench and it was with dread that we approached the crater's edge, fearing that we would pay with our lives the penalty of our daring.

"The return trip of 40 miles was made without mishap in spite of the terrific strain to which the car had been put in making the outward journey. Not one single mechanical mishap occurred, though if it had we would have been in a sorry plight, as no one in our party had the least bit of mechanical ability. Our very lives depended on the reliability of 'Death Valley Dodge,' and the old veteran of many desert battles maintained its reputation as it has on every one of its many trips heretofore through the mountains and deserts of the Southwest."

FOULING SPARK PLUG KEPT LOW BY GOOD OIL

Burning of the gasoline and lubricating oil in the cylinders by the explosion of the gases causes carbon, which is in solution in both liquids, to free itself and adhere to the cylinder walls, spark plugs and pistons in the form of nearly pure carbon. A high grade oil, with the proper gasoline mixture and tight piston rings, which will keep surplus oil below the pistons where it belongs, will reduce spark plug fouling to the minimum.

If a motor misses, surplus oil will collect in the plug, there being no fire to burn it out, and cause fouling.